

Hanguana podzolicola (Hanguanaceae), a new record for Singapore

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ABSTRACT. *Hanguana podzolicola* (Hanguanaceae) is newly recorded for Singapore. Detailed colour plates are given alongside the main characters for distinguishing this species from the two most similar species in Singapore, *Hanguana rubinea* and *H. triangulata*. The seeds of *Hanguana podzolicola* are described for the first time. A local conservation assessment is given. As no original material of *Hanguana podzolicola* could be traced, a neotype is designated here. Following a recent clarification of several historical *Hanguana* names it is noted here that the correct name for the large helophytic stoloniferous species often cultivated in Singapore under the name *Hanguana malayana* is *Hanguana anthelminthica*. An updated key to *Hanguana* species in Singapore is provided.

Keywords. Central Catchment Nature Reserve, *Hanguana anthelminthica*, *H. malayana*, *H. pantiensis*, IUCN conservation assessment, Johor, neotypification, Peninsular Malaysia

Introduction

In a recent overview of *Hanguana* Blume in Singapore, Leong-Škorníčková & Boyce (2015) recognised four native, one introduced, and one cultivated species. Since the publication of this paper, fieldwork on Hanguanaceae has continued and a survey of all populations of *Hanguana*, along with a systematic survey of the primary forest habitats of Zingiberales in Singapore, has been undertaken (Niissalo et al., 2017). During these surveys we found a population of a species that has not been previously reported from Singapore.

We have compared our material to all seven *Hanguana* species so far described from Peninsular Malaysia (Jack, 1820; Siti Nurfaizilah et al., 2010; Leong-Škorníčková & Kiew, 2016). The plants in Singapore are similar to two species described from Johor, *Hanguana podzolicola* Siti Nurfaizilah et al. and *H. pantiensis* Siti Nurfaizilah et al., in their leaf characters, small fruits and strongly obliquely positioned stigmas, although, of these two, the spreading, long inflorescence branches of the Singaporean plant

better fit *H. podzolica*. We have not seen individuals with particularly pronounced aerial stems in Singapore, but based on our observations in Singapore and Peninsular Malaysia, we believe that this character has little taxonomic value, as it is regularly seen in many taxa and is likely an indication of an old individual. Siti Nurfazilah et al. (2010) only reported female plants and, likewise in Singapore, only female plants have been collected. We provide a full description, including the previously undescribed seeds, and photographic illustrations of the species based on the Singapore population to aid future taxonomic work.

The type specimens and all paratypes for the five names published in Siti Nurfazilah et al. (2010) were never deposited in KEP. The whereabouts of these materials, including those of *Hanguana podzolica*, remain unknown. There are no morphologically well-matched specimens of *Hanguana podzolica* from the type locality or nearby areas in any of the herbaria we have examined (E, K, KEP, L, P, SING). A single sheet of *Hanguana podzolica* was found at USM (Mohd Fahmi Bin Abu Bakar et al. 59; Sofiman Othman, pers. comm), but this collection is not mentioned in the protologue and it is not from the type locality. The specimen consists of a young female inflorescence, but it has no leaves or fruits and therefore does not allow for unambiguous identification of the species. As the population in Singapore appears to be morphologically inseparable from the plants from the type locality illustrated by Siti Nurfazilah et al. (2010), we designate a neotype from a fully ripe female specimen collected in Singapore.

We consider the two specimens, *Corner s.n.* from Mandai Road and *Ridley 170* from Seletar, previously cited with caution as *Hanguana rubinea* Škorničk. & P.C.Boyce by Leong-Škorníčková & Boyce (2015), to rather be *H. podzolica* as they match the living material seen in all aspects, most prominently in the large size of the female inflorescences. The ripe fruit on *Corner s.n.* also matches *Hanguana podzolica* in the strongly obliquely positioned stigmas and seed structure.

The vegetative parts of this species, especially the corrugated leaves and fairly prominent flocculose indumentum, are very similar to those of *Hanguana triangulata* Škorničk. & B.C.Boyce. Our preliminary results from genetic analyses of Singapore's *Hanguana* populations (Niissalo et al., manuscript in preparation) suggest that the sterile specimen from Upper Seletar originally cited by Leong-Škorníčková & Boyce (2015) under *H. triangulata* (Leong-Škorníčková, J. & Thame, A. JLS-3036), is genetically part of the same population as our collections of fertile *H. podzolica*. We therefore correct its identification to *Hanguana podzolica* here. The only surviving populations of *Hanguana triangulata* are therefore in Bukit Timah Nature Reserve and, as confirmed by the preliminary results of our analyses, all plants with corrugated leaves in the northern parts of the Central Catchment Nature Reserve are *H. podzolica*. In the fruiting stage these two taxa are not easily confused as *Hanguana podzolica* has much longer and more slender inflorescence branches (to c. 30 cm), smaller pink fruits (c. 5–7 mm in diam.) that turn translucent green-dull pink to green-brown as they ripen, and strongly obliquely positioned and rounded stigma lobes (compared to short and almost perpendicular branches to 8 cm long, larger cream-white fruits 9–10 mm in diam., a stigma which is terminal or slightly

oblique, and stigma lobes which are connate at base and with sharp apices forming an equilateral triangle in *H. triangulata*). In addition the seed has a single, broadly and bluntly acute appendage (compared to the seed appendage bluntly bilobed in *H. triangulata*). *Hanguana podzolicola* is also similar in stature and inflorescence details to *H. rubinea*, but differs from it by its prominently corrugated leaves and abaxially more thickly flocculose indumentum (compared to the almost flat lamina with a sparse indumentum in *H. rubinea*). They also differ in inflorescence branch length, fruit, and seed details (in *Hanguana rubinea* branches are up to 11 cm long, fruits are larger, 9–10 mm in diam., and turn ruby-red as they ripen, stigma is terminal or only slightly oblique, stigma lobes are similar to *H. podzolicola*, except larger, and the seed appendage is triangular). *Hanguana podzolicola* has the largest female inflorescences of any native *Hanguana* in Singapore.

With the recent work on *Hanguana* in Singapore (Niissalo et al., 2014; Leong-Škorníčková & Boyce, 2015), the current paper brings the number of native *Hanguana* species in Singapore to five. *Hanguana malayana* (Jack) Merr., the name provisionally applied to the cultivated massive helophyte by Leong-Škorníčková & Boyce (2015; see Fig. 1 & 11–12), is here updated to *Hanguana anthelminthica* (Blume ex Schult. & Schult.f.) Masam. to reflect a recent clarification of the old names of *Hanguana* (Leong-Škorníčková & Niissalo, 2017). *Hanguana malayana* is a solitary forest species that is so far only known from Penang and has never been collected from Singapore, whereas *Hanguana anthelminthica* is the widespread massive helophyte that is also widely cultivated in the tropics, including in Singapore. An updated key to all *Hanguana* species in Singapore is provided.

Hanguana podzolicola Siti Nurfazilah et al. – TYPE: Singapore, Mandai Road, 24 Aug 2015, Leong-Škorníčková, J. HAN-76 (neotype SING [mounted over 2 sheets and including fruits preserved in spirit as part of a single specimen], here designated). (Fig. 1, 2)

Herbaceous, dioecious mesophyte to c. 1.6 m tall; stem terete, to 3 cm in diam., basally semi-ascending, with age becoming leafless, terminally ascending with crown of up to 20 leaves; *stolons* absent. **Leaves** to 170 cm long, spreading then arching, bases imbricate margins hyaline (young leaves), turning erose-marcescent with age; *pseudopetiole* 60–70 cm long, c. 10–14 mm wide, accounting for 1/3–1/2 of entire leaf length, roundly channelled with sharp margins, strigose; *leaf blade* 80–105 × 14–17 cm, narrowly elliptic, base attenuate, tip long, narrowly attenuate with apicule c. 4 mm, leathery, irregularly corrugated, adaxially mid to dark green, sparsely hairy (silky appressed hair; falling off in older leaves), abaxially lighter green when fresh, prominently flocculose (falling off in older leaves); *midrib* weakly impressed, of the same colour as the rest of the lamina adaxially, round-raised, lighter green, almost glabrous and shiny abaxially. **Male inflorescences** not observed, female inflorescences erect at anthesis. **Female inflorescence/infructescence** erect, comprising up to 9 partial, whorled, alternate-secund, thyrsoid infructescences plus a terminal spike;



Fig. 1. *Hanguana podzolicola* Siti Nurfazilah et al. **A.** Lower side of the lamina showing flocculose indumentum. **B.** Upper side of the lamina. **C.** Habit (inset: detail of the petiole). **D.** Detail of young fruits (photographed on 29 Apr 2015) **E.** Detail of ripe fruits (photographed from the same individual on 24 Aug 2015). **F.** Infructescence. From Leong-Škorníčková, J. HAN-76. (Photos: Jana Leong-Škorníčková)

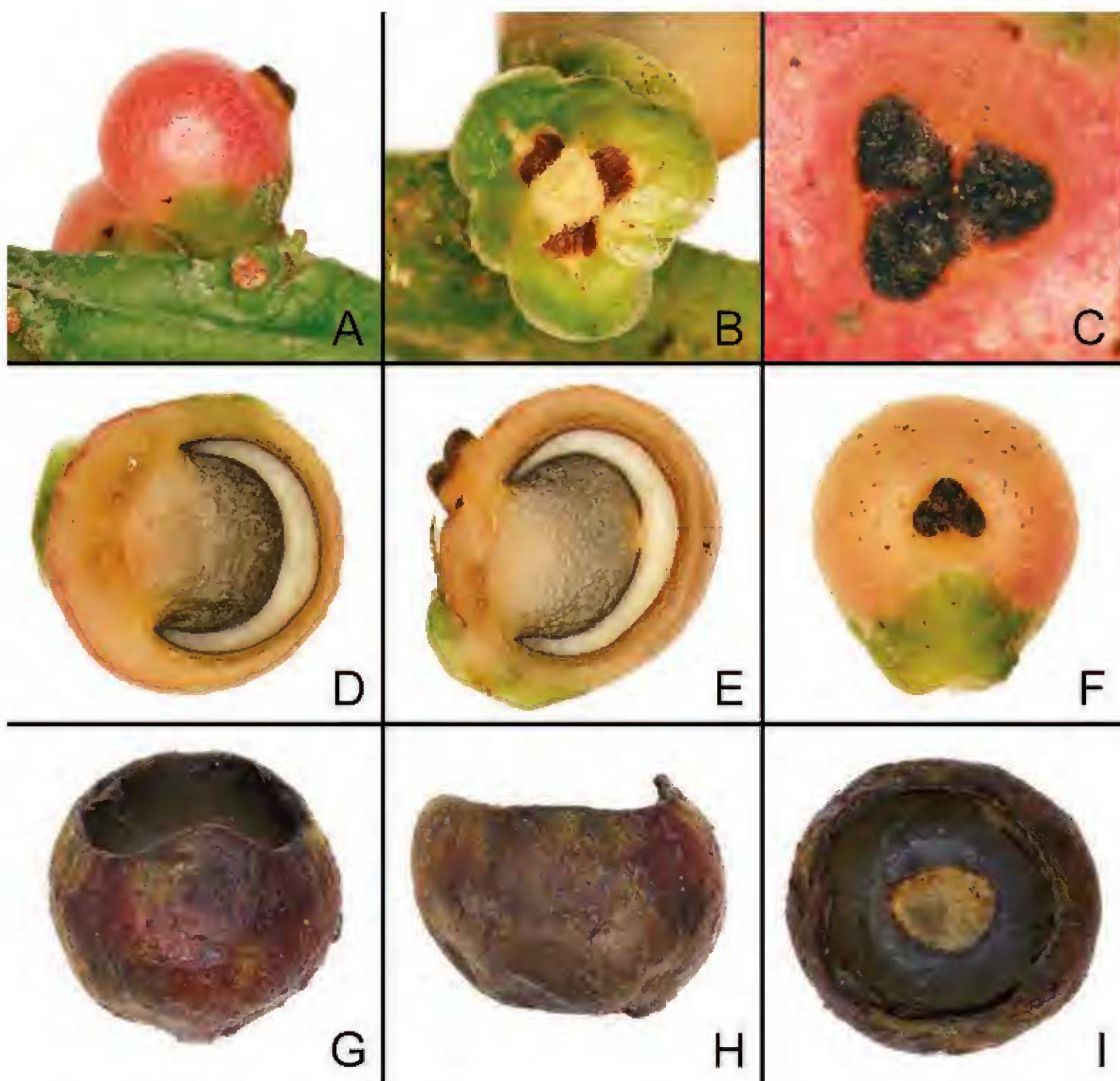


Fig. 2. *Hanguana podzolicola* Siti Nurfaizilah et al. **A.** Side view detail of fruit attached to a branch showing tepals tightly clasping the base of the fruit. **B.** Detail of inner tepals, staminodes and staminodial scales. **C.** Detail of stigma. **D.** Cross section of fruit showing single seed and two empty locules. **E.** Longitudinal section of fruit. **F.** Fruit in top view, showing asymmetrically placed stigma. **G.** Seed (side view, appendage facing camera). **H.** Seed (side view, appendage to the right). **I.** Seed (top view, appendage to the left). From Leong-Škorničková, J. HAN-76. (Photos: A–F: Jana Leong-Škorničková; G–I: Matti A. Niissalo)

partial inflorescences spreading almost perpendicularly to rachis (lowermost 2 ascending); *peduncle and rachis* together up to 90 cm tall, green when fresh, conspicuously pale brown-grey flocculose, visible portion of peduncle up to 30 cm long; one sterile bract per peduncle, foliaceous, persistent, narrowly ovate with a basal claw, c. 95 (incl. 30 cm long claw/pseudopetiole) × c. 11 cm; *bract subtending partial inflorescences* similar to sterile bracts, diminishing in size and becoming narrowly triangular distally along the infructescence, the bract supporting basal-most partial

inflorescences c. 50×10 cm (incl. 6 cm claw), fully reduced in uppermost partial inflorescences; *partial inflorescences* each comprising up to 17 branches at basal levels (occasionally two branches connate at base; fewer towards the apex of the inflorescence), branches arising simultaneously from the axil of the subtending bract, lateral branches progressively shorter in length (outermost lateral branches $1/2$ – $2/3$ of the median branch), median branches at basal levels usually further branched, 20–30 cm long (10–25 cm long in upper levels). **Female flowers** scattered, solitary or in pairs, sessile, all with an associated minute bract and bracteole; *perianth* composed of 6 tepals in two whorls tightly clasping ovary/fruit in fresh material, all tepals with prominent bulbous thickening at base (more prominent in outer whorl), light green, margin c. 0.2–0.3 mm wide, hyaline translucent white; *outer tepals* broadly ovate, 2.5–3 mm long, c. 2.8–3 mm broad, connate at base (only 0.3 mm), sparsely arachnoid; *inner tepals* almost circular, c. 3 mm long, 3–3.2 mm broad, free to base, almost glabrous; *staminodes* 6, in two whorls, pale green to cream white, triangular, *outer staminodes*, 0.3–0.4 mm long, 0.2–0.3 mm broad at base, inner staminodes longer, narrowly triangular, c. 1 mm long, 0.2–0.3 mm at base, each basally sheathed with a broad narrow scale (often shallowly bilobed), c. 0.8–0.9 mm long, and c. 1.2 mm broad, brown with translucent margin, *stigma* 3-lobed, c. 1.5 mm in diam., each lobe 0.8–1 mm long (fruiting material), broadly ovate with round apex, lobes connate basally, with points of connation seen as grooves, matte dark brown (fruiting stage); *position of stigma in ripe fruits* strongly oblique (only a single seed ever develops). **Ripe fruit** with pink blush externally (ripe fruit appears dirty green-pink or green-brown as the dark seed colour is visible through the increasingly translucent pulp), globose, 5–7 mm diam.; *pulp* 0.7–1 mm thick, pale yellow, fairly hard, ripening from cream-white with bright pink blush, to dirty pale yellow with dull pink tinge; *seeds* 1 per fruit (2 seeds in a single fruit have not been observed), c. 5×4 mm, brown, deeply bowl-shaped with slightly incurved margins, with a small broadly bluntly acute appendage positioned on the distal part of the rim, cavity filled with placental tissue.

Distribution. Both the historic and recent collections of this species in Singapore are from the northern parts of the Central Catchment Nature Reserve or locations immediately adjacent to it. The species is now only found in the Nee Soon Freshwater Swamp-forest (NSFS). One historic collection locality, Seletar, has likely been deforested, but the locality name was used for a larger swamp-forest complex that was once connected to NSFS (O'Dempsey & Chew, 2013). In Peninsular Malaysia the species has been recorded from two localities in Johor, Hutan Simpanan Lenggong, Mersing and Hutan Lipur Panti, Kota Tinggi (Siti Nurfaizilah et al., 2010).

Ecology & phenology. In Singapore *Hanguana podzolicola* is strictly a swamp-forest species, occurring in locations with permanently wet or flooded soil in NSFS. The only other species recorded there, *Hanguana rubinea*, occurs in drier locations. The two are only occasionally sympatric at the edges of the swamp forest (Upper Seletar and southern end of NSFS). Based on historical collections and our observations, the species flowers early in the year (c. March) and fruits ripen by July–August.

Provisional IUCN conservation assessment. The known Extent of Occurrence of *Hanguana podzolicola* is c. 500 km² and the species is currently only known from three localities, with an estimated Area of Occupancy of c. 10 km². Two of the known localities are in protected areas, but the third is highly susceptible to forest loss. The species should therefore be considered to be Endangered globally, EN B1ab(iii) (IUCN, 2012). In Singapore there are c. 50 stems, all solitary, and the majority of them are found within a small area (c. 1/2 ha) of particularly wet, low-lying forest, with only very few or single stems elsewhere in NSFS. Given the small number of stems, small total area of occupancy and the highly clustered distribution, the species should be considered Critically Endangered (CR C2) nationally using the slightly amended national categories of Davison et al. (2008).

Additional specimens examined. SINGAPORE: **Seletar:** 29 Mar 1889, Ridley, H.N. 170 (SING, female flowers). **Central Catchment Nature Reserve:** Mandai Road, 28 Jul 1929, Corner, E.J.H. s.n. (SING, fully ripe infructescence); forests around Upper Seletar Reservoir, 19 Aug 2014, Leong-Škorničková, J. & Thame, A. JLS-3036 (SING, sterile); Mandai Road, 29 Apr 2015, Leong-Škorničková, J. & Niissalo, M. HAN-75 (SING, leaf and old infructescence).

Notes: The fruit colour develops in an unusual way in this species, and the fruits illustrated in Siti Nurfaizilah et al. (2010) are not yet fully ripe. In the fruits we have observed, the fruits have nearly reached their mature size by late April. At this point the fruits have a bright pink coloration, but they remain unripe and the seeds remain soft. The fruits ripen very slowly and become more translucent over time. As the seeds ripen dark brown, the fruits appear dirty greenish-dull pink or even green-brown when the seeds are fully developed. This ripening stage lasts for about five months after the fruits have their final size (Fig. 1), bringing the total flowering and fruiting process to last 7–8 months.

Singapore plants overall agree closely with measurements from Malaysia (Siti Nurfaizilah et al., 2010), but the petioles we measured are proportionally longer (1/3 of leaf length in Malaysia, up to 1/2 of leaf length in Singapore), and the outer whorls of petals are also slightly larger in Singapore than in the Malaysian plants (1 × 1.8 mm in Malaysia, 2.5–3 × 2.8–3 mm in Singapore). However, when comparing photographs of the fruits of both Malaysian and Singapore collections, the proportional dimensions of outer and inner tepals compared to diameter of the fruits appears to be identical.

Leong-Škorničková & Boyce (2015) discussed the taxonomic importance of oblique stigmas in *Hanguana* and, as they mention, oblique stigmas can occur in many *Hanguana* species when only a single seed develops inside the fruit. However, in *Hanguana podzolicola* (and apparently *H. pantiensis*) the stigma is very strongly oblique, even closer to the base of the fruit than the apex, and such a strongly oblique stigma is an unmistakable character of taxonomic significance. It is also well preserved in dry material. The species is also characterised by the thick, flocculose indumentum, but this character is often lost on old herbarium specimens and also on the older leaves of live plants and therefore unreliable for herbarium-based taxonomy.

Updated key to *Hanguana* in Singapore

- 1a. Large stoloniferous colonial herbs 2
- 1b. Solitary or clumping herbs lacking stolons 3

- 2a. Leaves stiffly erect with acute apex; lamina more or less flat or weakly irregularly corrugate, semi-matt green; staminodial scales composed of lobes without a hyaline margin; stigma lobes large, flat, connate at base, forming a bluntly triangular to clover-leaf shape, almost obscuring the apex of ovary
..... *H. anthelminthica*
- 2b. Leaves weakly arching, with long-attenuate apex; lamina prominently corrugate, shiny green with a visible pattern of lighter and darker green (best observed on young and medium aged leaves); staminodial scales entire with a hyaline margin; stigma lobes small, erect, separate, teardrop-shaped to obovate *H. nitens*

- 3a. Leaves green on both sides 4
- 3b. Leaves dark emerald-green above and dark red-purple underneath *H. corneri*

- 4a. Large herbs over 1 m in height; leaves arching; ripe fruits cream-white, dull pink or ruby red; seeds bowl-shaped, more or less hemispherical 5
- 4b. Medium sized herbs not exceeding 0.8 m in height; leaves spreading (not arching); ripe fruits black; seeds 3/4 globose to ovoid with wedge-shaped opening
..... *H. neglecta*

- 5a. Lamina almost flat, abaxially with evenly distributed silky indumentum; ripe fruits ruby-red; stigma lobes connate basally (sometimes imperfectly), with round apices *H. rubinea*
- 5b. Lamina more or less corrugate, abaxially with unevenly distributed flocculose indumentum, ripe fruits cream-white or dull pink 6

- 6a. Ripe fruits cream-white, 9–10 mm in diam.; stigma lobes with sharply acute apices, forming sharply triangular structure; seed appendage bluntly bilobed
..... *H. triangulata*
- 6b. Ripe fruits dull pink, 5–7 mm in diam.; stigma lobes connate basally (sometimes imperfectly), with round apices, forming bluntly triangular structure; seed appendage single, broadly bluntly acute *H. podzolicola*

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Hanguana podzolica specimens are present at USM and for providing us with photographs of two collections. Dr David Middleton and the reviewers are thanked for linguistic help and constructive comments on this manuscript.

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